SNOLAB: An International Facility for Underground Science

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Abstract. SNOLAB, an international facility for underground science, is presently under construction at a depth of 6000 meters of water equivalent (m.w.e.) at Inco's Creighton mine near Sudbury, Ontario, Canada. Building on the success of the Sudbury Neutrino Observatory, the creation of SNOLAB will provide the deep-site infrastructure required of next generation particle-astrophysics experiments in pursuit of low-energy solar neutrinos, neutrinoless double beta decay, and cosmological dark matter. Following an enthusiastic response from the scientific community to a call for Letters of Interest (LOI's) in staging experiments at SNOLAB, an initial set of recommendations have been developed to guide the scientific program at this new facility.

Keywords: Sudbury, Underground Laboratory, Cosmic Ray Muons, Solar Neutrinos, Double Beta Decay, Dark Matter

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OVERVIEW

SNOLAB [1] is being developed at the site of the Sudbury Neutrino Observatory (SNO) at the Creighton Mine near Sudbury in Canada. Sudbury is located about 400 km north of Toronto and is accessible by regular flights from Toronto, Ottawa, or Sault Ste. Marie, or by major highways from any of these locations. The mine is about 25 km west of the city. The city of Sudbury is a major infrastructure center for northern Ontario and is home to Laurentian University, English and French language colleges, and regional hospitals in addition to the industrial support base. The Creighton Mine is an active nickel and copper mine owned and operated by Inco. At the start of the SNO project the Creighton Mine boasted the deepest continuous shaft in the western world. The currently active shaft runs from surface to a depth of 7000 feet and mining is progressing below this level. The SNOLAB facility is located on the 6800 foot level, a depth of 6000 meters of water equivalent and will provide the overburden required to shield cosmic ray muons and their progenies [2] from next generation detectors of low-energy solar neutrinos, neutrinoless double beta decay, and cosmological dark matter [3].

Development of the infrastructure requirements and scientific program for SNOLAB has evolved through a series of workshops, the first of which was established in Sudbury on August 20, 2002 and served largely as an informational meeting to inform the community on the basic opportunities at SNOLAB and to solicit interest in mounting experiments at this new facility. A second workshop was organized in Ottawa from November 21-22, 2002 that invited proponents of perspective experiments and initiated a program to define the infrastructure needs for SNOLAB in support of these experiments. An official call for LOI's in staging experiments at SNOLAB was issued on January 26, 2004 [1]. This call was met with great enthusiasm as shown in Table 1 and was followed by a third and very successful workshop held in Sudbury from May 12-14, 2004 which served to refine the infrastructure needs and conceptual layout of the laboratory, and to begin the experiment evaluation process.

Table 1: Scientific Interest in SNOLAB

Experiment	Scientific Thrust
Majorana	Double Beta Decay
GerDA	Double Beta Decay
EXO	Double beta Decay
COBRA	Double Beta Decay
Lithium Detector	Solar Neutrinos
SNO++	Solar and Geo-Neutrinos
Noble Liquid Tracking	Solar neutrinos
LENA	Solar Neutrinos and Proton Decay
CLEAN	Solar Neutrinos and Dark Matter
CDMS	Dark Matter
PICASSO	Dark Matter
ZEPLIN	Dark Matter
XENON	Dark Matter
DEAP	Dark Matter
DRIFT	Dark Matter
HALO	Supernova Neutrinos
NASTOS	Neutrino Oscillations
TRIGA	Neutron-Antineutron Oscillations

Following this series of workshops [1] and the receipt of LOI's, the conceptual layout for the underground laboratory spaces evolved from a single, monolith-type hall to three distinct "classes" of space referred to as, the Rectangular Hall, the Ladder Laboratories, and the Cryopit. The SNO cavern and existing experimental facility will become available for new endeavors once decommissioning of the SNO experiment is complete. In addition to the existing SNO cavern and experimental area, SNOLAB will provide an additional 36,000 square feet of new excavations for a total of 45,000 square feet of clean underground space. A medium-to-large scale (~15 m) experiment will be accommodated in the Rectangular Hall. A set of Ladder Laboratories can accommodate 2-3 experiments of smaller footprint (~4-6 m) where the overhead height provided by the larger cavities is not required. The Cryopit would provide a cylindrical space for a large-scale (~15 m) cryogenic experiment that can be physically isolated safely from personnel and other ongoing and parallel experiments. In addition, smaller spaces are available to accommodate prototype detectors of order 1-2 m in scale. The new surface building will serve in support of the underground program with office space, computing facilities, and meeting rooms. Both high bay and standard laboratory space will be available together with infrastructure for clean assembly and transport of equipment underground.

STATUS

LOI's and eventual proposals to stage experiments at SNOLAB are reviewed by an Experiment Advisory Committee (EAC). At the IV'rth SNOLAB workshop, held in August, 2005 in the new SNOLAB surface building, the EAC provided its first recommendations on Science for SNOLAB, including advice on an initial suite of experiments considered pertinent to the longer term development of a scientific program for SNOLAB. Three broad recommendations were made and the reader is referred to ref.[4] for details on specific recommendations for experiments:

1. We recommend a scientific program that exploits the Sun as a unique source of neutrinos to explore the basic tenets of stellar evolution, fundamental neutrino properties, and the possibility of new interactions amongst the fundamental constituents of matter.
2. We recommend a scientific program aimed at observing the rare process of neutrinoless double beta decay, the only practical means of determining the absolute mass scale of the neutrino and whether or not the neutrino is its own antiparticle. The program should aim, as a next step, for a precision measurement in the degenerate mass regime and encourage the development of new technologies capable of sensitivity to the inverted mass hierarchy and beyond.
3. We recommend a scientific program aimed at the direct detection of WIMP dark matter. The "state-of-the-art" should be exploited while developing new and complementary detector technologies capable of scaling to target masses of order 1-tonne and beyond. Consideration should be given to both spin-independent and spin-dependent detector technologies.

These recommendations mark a significant milestone toward the development of a scientific program for SNOLAB. With this, the construction of the SNOLAB underground facility is also proceeding well and on schedule. It is anticipated that some early, prototyping space, will become available in 2006 with the new experimental spaces available for occupation in 2007. With this schedule in mind, a User's Group has now been established that incorporates the experimental collaborations and SNOLAB management to assure the smooth transition to an operating scientific program at SNOLAB.

REFERENCES

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